RELIABILITY ASSURANCE

LIBRASCOPE GROUP
GENERAL PRECISION

STUDY OF FAILURE AND RELIABILITY OF MICROELECTRONICS DEVICES

12th QUARTERLY REPORT

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CONTRACT NAS 12-72

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TR 2-0501

1.0 INTRODUCTION

This report is submitted to summarize work accomplished by Librascope on Contract NAS 12-72, Modification 2 during the calendar quarter ending 30 September 1968.

2.0 SUMMARY

In this reporting period, 1 July through 30 September the following tests were completed, in accordance with Test Procedure TR 1-1529 on 5 Groups of surface defect categories:

Parameter Measurements at temperature extremes (+25, -55, +125 degrees C)
High Temperature Storage
Temperature Cycling
Acceleration

The specimen groups tested were as follows:

Group II, Best Available
Group III, Surface Particles
Group IV, Surface Blemishes
Group V, Metalization Defects
Group VI, Bridging

The foregoing defect categories are defined in detail in Appendix A of Test Procedure TR 1-1529, submitted with the 11th Quarterly Report.

Without predicting the source or composition of the surface anomalies, or their possible effects, each category, without losing identification, was subjected to the foregoing environmental extremes. The intent is to accelerate any deleterious effects, especially those statistically identifiable with a surface defect category. Parameter measurement data has not been statistically reduced, but no catastrophic failures have been encountered thus far. Life testing of the Group VII specimens is expected to begin by the end of October.

3.0 ACCOMPLISHMENTS

3.1 Measurements at Temperature Extremes D-C parameters were measured on all Groups II through VI devices at +25, -55 and +125 degrees C as described in Test Procedure TR 1-1529. The devices were installed in carriers and mounted on motherboards that provided Kelvin connections from the carrier connector through the chamber door and scanner cable to the tester. The tester is equipped with Kelvin connected metering. Measurement error was further avoided by flowing dry nitrogen through the chamber connectors thus preventing moisture accumulation at -55 degrees C. Repeatability, usually within 3 percent, was achieved between measurements through the chamber door at +25 degrees C and measurements made directly on the tester. Measurements at -55 degrees C resulted in 32 failures of output low voltage (V_{OL}). In all cases the output failed to switch to the low state when the specified forcing functions were imposed, indicating the input threshold level was higher than the specified 2.0 volts. None were catastrophic (open or shorted). More than 70 percent of these failures occurred in Group V (Metalization Defects). The remaining 30 percent occurred randomly among Groups III (Surface Particles), IV (Surface Blemishes) and VI (Bridging). None occurred in Group II (Best Available). All other parameter measurements at -55 degrees C were within their specified limits. Several marginal parameter failures (V_{OL}, V_{OH}, I_L and I_{RO}) were encountered during measurements at +125 degrees C. These failures were randomly distributed among the defect groups and displayed no significant pattern. No specimens were removed from the test.

3.2 High Temperature Storage All specimens of Groups II through VI were subjected to 240 hours of storage at +200 degrees C as specified in Test Procedure TR 1-1529. Specimen serial number 301 (Surface Particles) failed 2 parameter measurements (V_{OL} and I_L) during the post-environmental measurements. Measurements on all other specimens were within their specified limits, including those previously identified as failures at -55 or +125 degrees C.

3.3 Temperature Cycling The specimens of Groups II through VI were subjected to the temperature cycling test described in Test Procedure TR 1-1529 with one deviation. Duration of the transitions from -65 to +200 degrees C was 1 hour maximum, whereas 30 minutes was specified. Post-environmental measurements were performed after the specimens had stabilized at room temperature for 24 hours. Two specimens exhibited parameter failures during post-environmental measurements. Specimen serial numbers 301 (Surface Particles) and 417 (Surface Blemishes) exceeded the allowed limits for input load current (I_L) and output low voltage (V_{OL}). Specimen 417 exhibited this failure mode on all 4 gates while on specimen 301 only 1 gate was defective.

3.4 Acceleration All specimens of Groups II through VI were subjected to acceleration exposures in the Y_1 and Y_2 directions, as specified in Test Procedure TR 1-1529. The specimens were accelerated for at least 1 minute at 30,000 g in each direction. Post-environmental measurements revealed the same failure mode on specimen 301 as that previously encountered. Specimen 417, however, apparently recovered and exhibited no measurements that exceeded specified limits, as it did following temperature cycling.

3.5 Procedure Change Parameter measurement data will be recorded on the 80-column data sheets using only the number of digits consistent with the measurement module resolution. Zeroes will not be added, as indicated in paragraph 4.2 of Test Procedure TR 1-1529, when the measurement range provides only 3-digit resolution.

3.6 Parameter Data Correlation A data listing of parameter measurements for the specimens under test was received from Sylvania. This listing was compared to Librascope's initial measurement data for correlation. Approximately 20 percent of the data points were visually compared and no significant differences observed (usually within 5 percent or better). In addition, every measurement point, from a few randomly selected specimens from each group, were compared and indicated good repeatability. A few outliers were identified and they too compared favorably.

4.0 CONCLUSIONS AND RECOMMENDATIONS

It is apparent that the measurement data will have to be statistically reduced in order to extract any meaningful relationships between surface defect categories and device reliability. It also appears that these relationships, if any, will not emerge until some life testing results are known.

The input threshold voltage failures encountered in Group V at -55 degrees C occurred in sufficient quantity to indicate significance. This failure mode could conceivably result if the "Metalization Defects" were aggravated at low temperature and were severe enough to produce resistive paths. An accurate definition of the failure mechanism would require further analysis. It is not recommended that any further analysis be performed until some life test data is accumulated primarily because this failure mode could not be reproduced at room conditions.